FORM PTO-1390 (REV. 1-98) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	
1807-0151P	
U.S. APPLICATION NO. (if known, see 37 CFR 1.5)	
09/700926 NEW	

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/SE99/00936	May 31, 1999	June 24, 1998

TITLE OF INVENTION

DEVICE FOR POSITION DETERMINATION BY MEANS OF RADIO WAVES

APPLICANT(S) FOR DO/EO/US

LOVSEN, Hakan

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau). WO 99/67655
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(3)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(2)).
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.-1449 and International Search Report (PCT/ISA/210) w/ 4 documents

12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

13. ☒ A FIRST preliminary amendment.
    ☐ A SECOND or SUBSEQUENT preliminary amendment.

14. ☐ A substitute specification.

15. ☐ A change of power of attorney and/or address letter.

16. ☒ Other items or information:
    1.) PCT Request (PCT/RO/101)
    2.) International Preliminary Examination Report (PCT/IPEA/409)
    3.) Two (2) sheets of Formal Drawings

U.S. APPLICATION NO (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
09/700926	PCT/SE99/00936	1807-0151P

17. ☒ The following fees are submitted:

CALCULATIONS	PTO USE ONLY

BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5):

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO..... **$1,000.00**

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$860.00**

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO..... **$710.00**

International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$690.00**

International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4)..... **$100.00**

ENTER APPROPRIATE BASIC FEE AMOUNT = $ **1000.00**

Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)). $ **0**

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total Claims	20 - 20 =	3	X **$18.00**	$ **0**
Independent Claims	1 - 3 =	0	X **$80.00**	$ **0**
MULTIPLE DEPENDENT CLAIM(S) (if applicable)		Yes	+ **$270.00**	$ **270.00**
		TOTAL OF ABOVE CALCULATIONS =		$ **1270.00**
Reduction of ½ for filing by small entity, if applicable. Verified Small Entity statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28).				$ **0**
		SUBTOTAL =		$ **1270.00**
Processing fee of **$130.00** for furnishing the English translation later than ☐20 ☐30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$ **0**
		TOTAL NATIONAL FEE =		$ **1270.00**
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$ **40.00**
		TOTAL FEES ENCLOSED =		$ **1310.00**
			Amount to be: refunded	$
			charged	$

a. ☒ A check in the amount of $ **1310.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account. No. _____ in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 02-2448.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

Send all correspondence to:
Birch, Stewart, Kolasch & Birch, LLP or Customer No. 2292
P.O. Box 747
Falls Church, VA 22040-0747
(703)205-8000

SIGNATURE

BIRCH, TERRELL C.
NAME

#19,382 (TCB)
REGISTRATION NO.

/cqc November 21, 2000

(REV. 09/29/2000)

PATENT
1807-0151P

IN THE U.S. PATENT AND TRADEMARK OFFICE

Applicant:	LOVSEN, Hakan		
Int'l. Appl. No.:	PCT/SE99/00936		
Appl. No.:	New	Group:	
Filed:	November 21, 2000	Examiner:	
For:	DEVICE FOR POSITION DETERMINATION BY MEANS OF RADIO WAVES		

PRELIMINARY AMENDMENT

BOX PATENT APPLICATION
Assistant Commissioner for Patents
Washington, DC 20231

November 21, 2000

Sir:

The following Preliminary Amendments and Remarks are respectfully submitted in connection with the above-identified application.

AMENDMENTS

IN THE SPECIFICATION:

Please amend the specification as follows:

Before line 1, insert --This application is the national phase under 35 U.S.C. § 371 of PCT International Application No. PCT/SE99/00936 which has an International filing date of May 31, 1999, which designated the United States of America.--

REMARKS

The specification has been amended to provide a cross-reference to the previously filed International Application.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,

BIRCH, STEWART, KOLASCH & BIRCH, LLP

By _____ #34,313
Terrell C. Birch, #19,382

P.O. Box 747
Falls Church, VA 22040-0747
(703) 205-8000

TCB/cqc
1807-0151P

(Rev. 04/19/2000)

Device for position determination by means of radio waves

TECHNICAL FIELD

The invention relates to a device for position determination by means of radio waves, preferably microwaves. In particular, it relates to successive position determination of vehicles on a roadway.

BACKGROUND ART

In a method for position determination by means of radio waves, so-called measuring in, a radio signal is emitted, preferably within the microwave range, where the signal has good directivity and the property of being reflected from objects, or, alternatively, of being reemitted with a device intended therefor. The reflected signal is received with two antennas, which are arranged so as to be at a distance from each other in a plane substantially perpendicular to the direction to the object. By the distance between the antennas, a wave reflected by the object will have a longer distance of travel to one of the antennas than to the other. This difference in the distance covered gives rise to a phase difference between the received signals. From the phase difference, a reference angle to the object in relation to the antennas may be calculated in a plane which is formed by antennas and object. Such a method is described, for example, in Swedish patent application No. 8403564-1. In this way, each position of the object corresponds to a certain phase difference.

The method is shown geometrically in Figure 1. The antennas 1 and 2 are placed at a distance d from each other. The object 3, or usually a so-called transponder on this object, the position of which is to be determined, reflects the emitted wave in a direction towards the antennas 1 and 2. Because the antennas are spaced at the distance d from each other, a difference ΔL in the distance covered arises. The difference ΔL gives rise to a

phase difference $\Delta\varphi = \varphi_1 - \varphi_2$, where φ_1 and φ_2 are the phase angle for the signal received at the antennas 1 and 2, respectively. From this phase difference $\Delta\varphi$, the geometrical angle θ may be calculated, $\sin\theta \propto \Delta L \propto \Delta\varphi$.

The angle θ is thus periodically dependent on the phase difference $\Delta\varphi$, as is clear from Figure 2. This means that there is an interval outside of which the angle θ is no longer unambiguous but may correspond to more than one position. This interval is inversely dependent on the distance d, that is, the interval increases when d decreases. Thus, from this point of view, it is desired to have as small a distance d as possible to achieve a large unambiguous region for the angle θ.

To achieve good directivity in an antenna, it is composed of a plurality of antenna elements to form so-called array antennas. Such an arrangement, of course, gives the antennas a certain physical extent and thus limits the distance d downward. The distance d in Figure 1 relates, for a pair of array antennas, to the distance between the respective antenna centers.

Hence, the requirement for good directivity conflicts with the requirement for a large unambiguous region. The invention suggests a device for satisfying the requirement for good directivity while at the same time maintaining the requirement for a large unambiguous region.

SUMMARY OF THE INVENTION

The invention is directed towards achieving a small distance between the centers of at least two array antennas while still allowing a large extent for the respective array antenna in order to permit both good directivity and a large unambiguous region. This is achieved according to the aspect of the invention by interweaving antenna elements of the array antennas with

one another in such a way that the antenna centers for the array antennas are at a small mutual distance. This is achieved according to the invention by connecting the various antenna elements in the array antennas such that the central antenna elements in the respective array antenna are arranged close to one another.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1 and 2 relate to the basic principles of the invention and are described above as prior art, whereas Figures 3, 4 and 5 relate to one aspect of the invention.

Figure 1 is a schematic picture of a principle of measurement in which the phase difference between two signals received in antennas are analyzed for position determination of an object by angular measurement with the antennas placed at a definite distance from one another,

Figure 2 illustrates the geometrical angular deviation for the object as a function of the phase difference,

Figure 3 shows an antenna arrangement according to the invention in a frontal view,

Figure 4 shows an alternative antenna arrangement according to the invention,

Figure 5 shows a block diagram for a device for measuring in, which utilizes an antenna arrangement according to the aspect of the invention.

DESCRIPTION OF EMBODIMENTS

Figure 5 shows a device for position determination of an object which travels along a path. The device comprises an amplification and signal-processing unit 17 connected to a signal processor 18 and an antenna arrangement 4 with two array antennas 1 and 2, the array antennas being arranged along a first axis perpendicular to the direction of travel of the object. The antenna arrangement comprises two arrays of conducting surfaces, antenna elements,

according to Figure 3. The array antenna 1 is formed of the five surfaces, antenna elements, 5-9 in such a way that the antenna elements 6-9 are placed peripherally around the central antenna element 5. In the same way, array antenna 2 is formed of the central antenna element 10 and the peripheral antenna elements 11-14. Through the output conductors 15 and 16, the antenna elements within the respective array are joined together to form the two array antennas 1 and 2. By means of the arrangement described, symmetrically arranged around the central antenna elements 5 and 10, respectively, these central surfaces, in the form of antenna elements, form the phase center of the respective array antenna. The distance between these two phase centers thus constitutes the distance d in Figure 1.

The width of the antenna 1 extends from the lefthand edge of the antenna elements 6 and 8 to the righthand edge of the antenna elements 7 and 9. The width of the antenna 2 extends from the lefthand edge of the antenna elements 11 and 13 to the righthand edge of the antenna elements 12 and 14. If the antennas were placed side by side, this would mean that the distance d between the respective phase centers 5 and 10 would become at least as large as the total width of an array antenna, and in practice more since there has to be a certain distance between the outermost antenna elements in the respective array antenna 1, 2. As is clear from Figure 3, however, the distance between the phase centers is considerably smaller, which thus is achieved by interconnecting the various antenna elements, in this embodiment by allowing the array antennas to be interwoven with one another.

The principle described may be utilized also in more complicated antenna arrangements. Thus, angle measurement may be refined by placing more than two antennas in such an arrangement, that is, with the antennas arranged along the first axis. The accuracy of measurement is, of course,

improved if it is possible to form the mean value over a large number of measurement results.

Another advantage of using more than two array antennas aligned on the same axis is given by the following. If the distance d between the centers of two array antennas increases, this implies that the distance ΔL increases for each angle θ. If the distance ΔL is increased, this implies an increased phase difference $\Delta\varphi$ for each change of angle, that is, the resolution is improved. Again, this comes into conflict with the requirement for unambiguity. By arranging a plurality of array antennas in a row on the same axis, for example, three antennas designated A, B and C in the mentioned order, the described conflict may be solved. By using the measured phase difference from data obtained from antennas A and B for the unambiguity and the measured phase difference between antennas A and C for obtaining an improved resolution, both requirements may be satisfied.

It is also possible to arrange antennas along several axes and hence permit measuring in at several planes. By placing at least one additional pair of array antennas along an axis substantially perpendicular to the first axis and substantially perpendicular to the direction of travel of the object, a reference angle to the object in relation to the antennas may thus be determined in each of the two planes, substantially perpendicular to each other, which are formed by the object and the respective axis on which pairs of antennas are arranged. If, as an example, the object consists of a vehicle travelling on a roadway, where array antennas are arranged along a horizontal first axis at such a height above the roadway that vehicles may pass under the antennas, a substantially horizontal first plane is defined by the antennas 1, 2 and the vehicle 3. In this horizontal plane, an azimuth angle θ to the vehicle may be determined, as described, by determining the phase angle φ. By arranging array antennas along a second axis, which is perpendicular to the first axis and substantially

perpendicular to the roadway, it is made correspondingly possible to determine an angle of elevation to the vehicle, where the angle of elevation refers to the vertical second axis. With knowledge of both the azimuth angle and the angle of elevation, as viewed from the two arrays of antennas, the position of the vehicle in relation to the antennas is determined from these angles.

An alternative embodiment with connection, according to the invention, between the different part surfaces arises by arranging certain antenna elements so as to be included in two or more array antennas. The embodiment is described schematically in Figure 4 for the case of measuring in in two dimensions. In this case, the antenna 20 comprises at least three array antennas. The array antenna 21 consists of the antenna elements 24-26, 28-30 and 32-34, where 29 constitutes the phase center. The array antenna 22 consists of the antenna elements 25-27, 29-31, and 33-35, with 30 being the phase center. The array antenna 23 consists of the antenna elements 28-30, 32-34 and 36-38, with 33 being the phase center. Thus, several antenna elements are used by more than one array antenna. This is made possible by power amplification of the signals received from at least these antenna elements and thereafter by applying power division to the amplified signal. In this embodiment, the same short distance d is obtained as in the previous embodiment.

CLAIMS

1. A device for determining the position of a vehicle on a roadway by using radio waves which are emitted from the device and reflected by the vehicle and received by at least two array antennas (1, 2) arranged across the roadway, **characterized** in that the array antennas (1, 2) comprise a number of antenna elements (5-14), one of the antenna elements in the respective array antenna constituting the phase center (5, 10) of the array antennas, and wherein the antenna elements (5-14) of the array antennas are connected to one another such that the distance (d) between the phase centers (5, 10) of the array antennas (1, 2) included is smaller than half the width of an individual array antenna (1, 2).

2. A device according to claim 1, **characterized** in that the connection comprises interweaving the array antennas (1, 2) with each other in that the phase center (5, 10) of one array antenna is arranged among the antenna elements (11-14, 6-9) of another array antenna (1, 2).

3. A device according to claim 2, **characterized** in that the phase centers (5, 10) of the respective array antennas (1, 2) are placed close to each other.

4. A device according to claim 2, **characterized** in that some of the antenna elements (24-38) are at the same time connected to more than one array antenna (21, 22, 23).

5. A device according to claim 4, **characterized** in that signals obtained from antenna elements (24-38) which are utilized by more than one array antenna (21, 22, 23) undergo power amplification, followed by power division of the amplified signal on the respective array antenna (21, 22, 23).

6. A device according to any of the preceding claims, **characterized** in that an azimuth angle θ to the vehicle (3)

is determined from an antenna position where at least one pair of substantially horizontally arranged array antennas (1, 2) is arranged.

7. A device according to claim 6, **characterized** in that an angle of elevation to the vehicle (3) is determined from an antenna position where at least one pair of substantially vertically arranged array antennas is arranged.

8. A device according to claim 7, **characterized** in that the position of the vehicle in relation to the antennas is determined by means of knowledge of the azimuth angle θ and the angle of elevation.

ABSTRACT

A device for determining the position of a vehicle on a roadway by using radio waves which are emitted from the device and reflected by the vehicle and received by at least two array antennas (1, 2) arranged across the roadway, wherein the array antennas (1, 2) comprise a number of antenna elements (5-14), one of the antenna elements in the respective array antenna constituting the phase center (5, 10) of the array antennas, and wherein the antenna elements (5-14) of the array antennas are connected to one another such that the distance (d) between the phase centers (5, 10) of the array antennas (1, 2) included is smaller than half the width of an individual array antenna (1, 2).

(Figure 3)

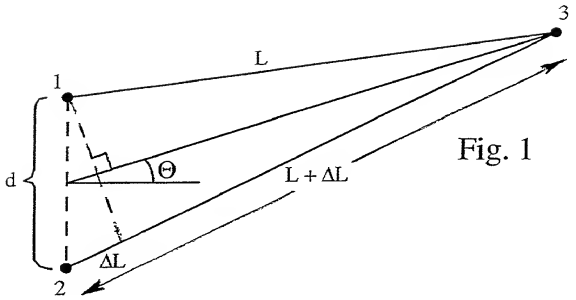


Fig. 1

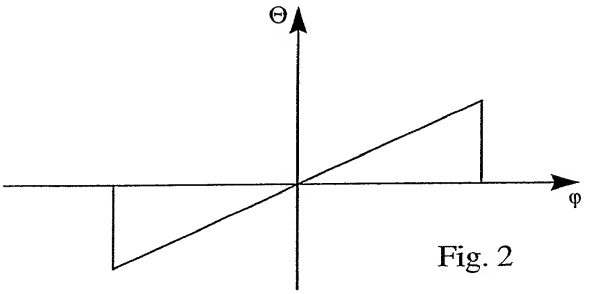


Fig. 2

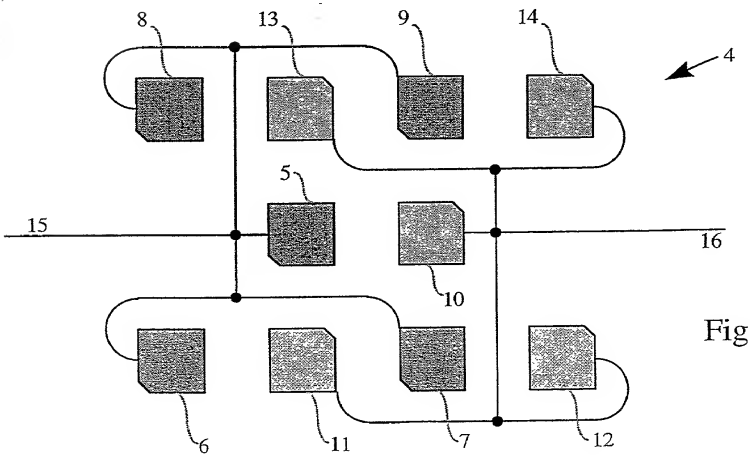


Fig. 3

Fig. 4

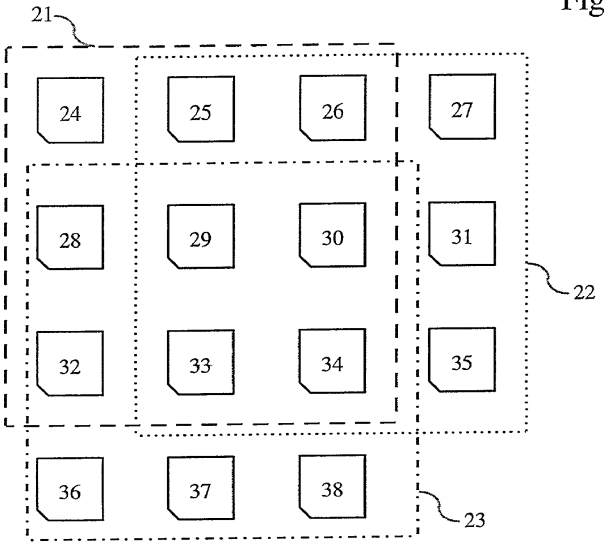
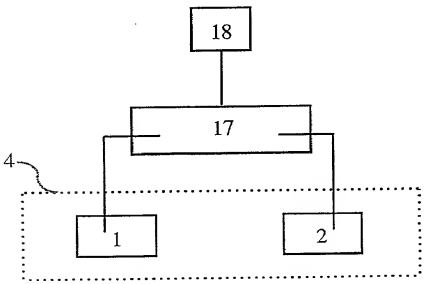


Fig. 5



BIRCH, STEWART, KOLASCH & BIRCH, LLP

PLEASE NOTE: YOU MUST COMPLETE THE FOLLOWING:

COMBINED DECLARATION AND POWER OF ATTORNEY

FOR PATENT AND DESIGN APPLICATIONS

ATTORNEY DOCKET NO. 1807-0151P

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated next to my name; that I verily believe that I am the original, first and sole inventor (if only one inventor is named below) or an original, first and joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Insert Title: Device for position determination by means of radio waves.

Fill in Appropriate Information - For Use Without Specification Attached:

the specification of which is attached hereto. If not attached hereto,

the specification was filed on _____ as
United States Application Number _____; and /or

the specification was filed on 31 May 1999 as PCT
International Application Number PCT/SE99/00936; and was
amended under PCT Article 19 on _____ (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I do not know and do not believe the same was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (six months for designs) prior to this application, and that no application for patent or inventor's certificate on this invention has been filed in any country foreign to the United States of America prior to this application by me or my legal representatives or assigns, except as follows.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 (a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Insert Priority Information: (if appropriate)

Prior Foreign Application(s)

(Number)	(Country)	(Month/Day/Year Filed)	Priority Claimed
9802234-6	Sweden	June 24, 1998	☒ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No

I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below.

Insert Provisional Application(s): (if any)

(Application Number)	(Filing Date)

All Foreign Applications, if any, for any Patent or Inventor's Certificate Filed More Than 12 Months (6 Months for Designs) Prior To The Filing Date of This Application:

Insert Requested Information: (if appropriate)

Country	Application No.	Date of Filing (Month/Day/Year)

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

Insert Prior U.S. Application(s): (if any)

(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)

I hereby appoint the following attorneys to prosecute this application and/or an international application based on this application and to transact all business in the Patent and Trademark Office connected therewith and in connection with the resulting patent based on instructions received from the entity who first sent the application papers to the attorneys identified below, unless the inventor(s) or assignee provides said attorneys with a written notice to the contrary:

15

Terrell C. Birch	(Reg. No. 19,382)	Raymond C. Stewart	(Reg. No. 21,066)
Joseph A. Kolasch	(Reg. No. 22,463)	James M. Slattery	(Reg. No. 28,380)
Bernard L. Sweeney	(Reg. No. 24,448)	Michael K. Mutter	(Reg. No. 29,680)
Charles Gorenstein	(Reg. No. 29,271)	Gerald M. Murphy, Jr.	(Reg. No. 28,977)
Leonard R. Svensson	(Reg. No. 30,330)	Terry L. Clark	(Reg. No. 32,644)
Andrew D. Meikle	(Reg. No. 32,868)	Marc S. Weiner	(Reg. No. 32,181)
Joe McKinney Muncy	(Reg. No. 32,334)	Donald J. Daley	(Reg. No. 34,313)
C. Joseph Faraci	(Reg. No. 32,350)		

Send Correspondence to: **BIRCH, STEWART, KOLASCH & BIRCH, LLP**
P.O. Box 747 • Falls Church, Virginia 22040-0747
Telephone: (703) 205-8000 • Facsimile: (703) 205-8050

PLEASE NOTE: YOU MUST COMPLETE THE FOLLOWING:

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

1-CD

Full Name of First or Sole Inventor: Insert Name of Inventor Insert Date This Document is Signed
Insert Residence Insert Citizenship
Insert Post Office Address

GIVEN NAME: Håkan | FAMILY NAME: Lövsén | INVENTOR'S SIGNATURE: Håkan Lövsén | DATE*: 27 Oct.2000
Residence (City, State & Country): Linköping, Sweden SE | CITIZENSHIP: Swedish
POST OFFICE ADDRESS (Complete Street Address including City, State & Country): Ektunavägen 89, S-589 33 LINKÖPING, Sweden

Full Name of Second Inventor, if any: see above

GIVEN NAME | FAMILY NAME | INVENTOR'S SIGNATURE | DATE*
Residence (City, State & Country) | CITIZENSHIP
POST OFFICE ADDRESS (Complete Street Address including City, State & Country)

Full Name of Third Inventor, if any see above

GIVEN NAME | FAMILY NAME | INVENTOR'S SIGNATURE | DATE*
Residence (City, State & Country) | CITIZENSHIP
POST OFFICE ADDRESS (Complete Street Address including City, State & Country)

Full Name of Fourth Inventor, if any see above

GIVEN NAME | FAMILY NAME | INVENTOR'S SIGNATURE | DATE*
Residence (City, State & Country) | CITIZENSHIP
POST OFFICE ADDRESS (Complete Street Address including City, State & Country)

Full Name of Fifth Inventor, if any see above

GIVEN NAME | FAMILY NAME | INVENTOR'S SIGNATURE | DATE*
Residence (City, State & Country) | CITIZENSHIP
POST OFFICE ADDRESS (Complete Street Address including City, State & Country)

* DATE OF SIGNATURE